Am. J. Trop. Med. Hyg., 83(3), 2010, pp. 559–564
doi:10.4269/ajtmh.2010.09-0485

Nutritional Status of Children after a Food-Supplementation Program Integrated with Routine Health Care through Mobile Clinics in Migrant Communities in the Dominican Republic

Kavita Parikh,* Gabriela Marein-Efron, Shirley Huang, Geraldine O'Hare, Rodney Finalle, and Samir S. Shah

Pediatric Hospitalist Division, Children's National Medical Center, Washington, DC; Pediatrics Residency Program, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; Divisions of GI, Hepatology, and Nutrition, Global Health, Infectious Diseases, and General Pediatrics, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; Departments of Pediatrics and Biostatistics and Epidemiology, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania

Abstract. The objective of this study was to compare acute and chronic undernutrition rates before and after the introduction of a food-supplementation program as an adjunct to routine health care for children of migrant workers in the Dominican Republic. The cross-sectional study was conducted in five rural communities in the Dominican Republic. Children 18 years and younger were eligible if they received routine health care from local mobile clinics. Data were obtained before (2005) and after (2006) initiation of a food-supplementation program. χ^2 or Fisher exact tests were used for analysis. Among 175 children in 2005, 52% were female, and 59% were < 5 years of age (mean age = 5.3 years). Among 148 children in 2006, 48% were female, and 57% were < 5 years of age (mean age = 5.6 years). Acute undernutrition rates decreased from 40% to 23% ($P = 0.001$) after initiation of the food-supplementation program. Rates of chronic undernutrition decreased from 33% to 18% after the initiation of the food-supplementation program ($P = 0.003$). Food supplementation in the context of routine health-care visits improved the nutritional status of children, and it warrants further exploration as a way to reduce childhood undernutrition in resource-scarce areas.

INTRODUCTION

Most of the 10 million deaths worldwide among children 5 years of age and younger are preventable.[1] Maternal and child undernutrition is the underlying factor of 3.5 million deaths or 35% of the disease burden in children less than 5 years of age.[2] Undernourished children have lower resistance to infection and are more likely to die of common childhood illnesses such as diarrhea and lower respiratory-tract infections. The Millennium Development Goals (MDG) were established by United Nations member states to address a range of global hardships by 2015.[3] One of the MDGs calls for a two-thirds reduction in mortality of children less than 5 years of age between 1990 and 2015. Because undernutrition is associated with 35% of deaths among children less than 5 years of age, this MDG cannot be achieved without steps to improve the nutritional status of young children.[2]

In the developing world, approximately one-quarter of children under the age of 5 years, or approximately 112 million children, are undernourished.[2] The framework of understanding undernutrition is complex and multifactorial, involving environmental, socioeconomic, and political factors. Although addressing general inequalities should be a priority, major reductions of undernutrition can be made through health and nutrition programs and interventions.[4] Various nutrition interventions have been implemented throughout the world, ranging from breastfeeding education, promotion of complementary feeding, food supplementation, micronutrient interventions, supportive strategies for family and community nutrition to reduction of disease burden with safe drinking water and improved sanitation and hygiene.[5] In 2000, The Food and Agriculture Organization of the United Nations reported that safety-net programs, which include food-assistance programs, aid vulnerable populations.[4] In a comprehensive review of supplementary feeding programs in developing countries conducted in the 1980s, Beaton and Ghassemi[6] showed that targeted supplementary programs for undernourished children in the absence of complementary health services showed no effect on their nutritional status.[6]

This study evaluated integrating a food-supplementation nutrition program with routine health care in rural migrant communities in the Dominican Republic. Undernourished children were identified and enrolled in a food-supplementation program that was linked to their routine health care. We hypothesized that integrating a food-supplementation program with routine health care would decrease the prevalence of acute and chronic undernutrition in these communities and could provide a means to reach remote populations.

METHODS

Setting and programmatic context. The bateyes of the Dominican Republic are economic migrant communities, primarily of Haitian and/or Dominican origin. The batey populations have unclear political status and often lack potable water, electricity, and sanitation facilities. The bateyes vary in size and poverty level. Approximately 200,000 habitants, representing 2% of the Dominican Republic population, live in the bateyes. The batey populations are geographically and economically isolated and have little access to health care. Since 2003, Global Health (formerly the Alliance for International Medicine) at The Children's Hospital of Philadelphia (CHOP) has partnered with Dominican physicians to provide care to children living in bateyes located in the southeastern part of the Dominican Republic. The Dominican physicians who serve the mobile clinics reach each batey monthly to provide general medical care, and CHOP Global Health has provided focused care for the pediatric population biannually since 2005.

Study participants. Children 18 years of age and younger were included in the study if they received routine health care (preventive or acute) from the mobile clinics. Children from five different bateyes (herein referred to by letters A–E) surrounding the town of Consuelo were studied. The bateyes selected for this study varied in population as well as proximity

* Address correspondence to Kavita Parikh, 111 Michigan Avenue NW, Main Building 4th Floor, Washington, DC 20010. E-mail: kparikh@cnmc.org

to the main town. The mobile clinic is designed specifically to provide access for marginalized and impoverished families.

Each bateye community has a designated community health worker who works closely with the mobile clinic. Community health workers were trained to identify high-risk children, collect proper anthropometrics, and counsel families on healthy nutrition practices by the CHOP Global Health teams at least two times a year. These community health workers, selected by local Dominican clinic physicians and staff, are also trained by the CHOP Global Health teams on how to educate and support families to promote health and nutrition. On clinic days, these community health workers go to homes to encourage families to bring children to the mobile clinic, especially if they appeared sick or malnourished. Children ages 0–18 years of age who were seen at the mobile clinic for both preventative and acute care were eligible for the Nutrition Program if they were considered to be undernourished.

Study design and intervention. A quasi-experimental study design was used, because it was neither logistically feasible nor ethical to conduct a randomized controlled trial of food supplementation.[7] To minimize threats to establishing causality, we conducted pre-intervention and post-intervention measurements in five separate bateyes.

Pre-intervention measurements were obtained in November 2005. The intervention, food supplementation as an adjunct to routine health care, was implemented during this month. Post-intervention measurements were recorded during November 2006. Pre- and post-intervention data included demographic information (age and sex) as well as height/length and weight measurements. Height or length measurements were made using portable stadiometers, and weight measurements were made using hanging or digital scales. The mobile clinic staff was trained on these measuring techniques to ensure reliable data collection.

The Nutrition Program, which involves distribution of low-cost food-supplementation packages, was initiated by the Dominican physicians. CHOP Global Heath helped to strengthen and develop this existing program through educational meetings and skill-building workshops. The CHOP Global Health team helped the nutrition program to focus on children at most risk for undernutrition and develop objective cut-points for undernutrition. The contents of the food-supplementation package were adjusted to provide optimal nutritional value given the local food market, accessibility, and cost. The food-supplementation package evolved from 2 lbs. of oatmeal and 1 lb. of milk powder in the initial stages of the program to 5 lbs. of rice, 1.5 lbs. of oatmeal, 2 cans of sardines, and 1.5 lbs. of dry milk currently. The food-supplementation package was distributed every 2 weeks, and the subsidized cost of each food package was 70 pesos [approximately $2 US dollars (USD)]. Children with severe undernutrition are referred to the large public hospital for the area, where the Ministry of Health has a malnutrition protocol for inpatient management.

This program distributed take-home food through mobile clinics for accessibility to rural communities by minimizing travel costs for the participants and avoiding costs of maintaining a food-distribution center and personnel. Children ages 0–18 years who were seen at the mobile clinic for preventive or acute medical care were eligible for the Nutrition Program if they were classified as having mild, moderate, or severe undernutrition based on World Health Organization (WHO)[8] or Waterlow and others[9] criteria, depending on age.

Classification of undernutrition. Length and weight measurements were recorded for each child, and nutritional status was classified for both acute and chronic cases. Classification of acute undernutrition, or wasting, was based on the use of one of two methods. For children with a length/height ≤ 120 cm, WHO Child Growth Standard weight for length/height tables were used.[8] Standard deviations (SD) for weight based on height based on the WHO tables allowed each child to be classified as normal (> –1 SD), mild (–1 to –2 SD), moderate (–2 to –3 SD), or severe (≥ –3 SD) undernutrition. For children with a height ≥ 120 cm, the percentage of actual weight to median weight for height was calculated using the US Centers for Disease Control and Prevention (CDC) 2000 growth charts, and the cut-off values for undernutrition were used based on criteria set by Waterlow and others.[9] Using these criteria, each child was categorized as normal (≥ 90%), mild (80–89%), moderate (70–79%), or severe (< 70%) wasting. Two separate criteria (WHO[8] and Waterlow and others[9]) were used, because the WHO reference tables used during the study period only included information for 0- to 5-year-old children. Waterlow and others[9] criteria using the US CDC 2000 growth charts were chosen to define undernutrition for children ages 5–18 years, because these growth charts include a well-established reference population. Chronic undernutrition, or stunting, was classified using the percentage cut-offs for actual height to median height for age and the US CDC 2000 growth charts. Each child was categorized as normal (≥ 95%), mild (90–94%), moderate (85–89%), or severe (≤ 85%).[9]

Statistical analysis. Categorical data are presented using counts and percentages. Continuous variables are presented using mean, median, range, or interquartile range values. Changes in proportion of undernourished children were compared using χ^2 tests. All analyses were conducted using STATA version 10 (Stata Corp., College Station, TX).

RESULTS

At baseline in November 2005, among 175 children living in five of the Consuelo bateyes who were seen for primary-care services, the majority were female and younger than 5 years of age. Similarly, in November 2006 after food supplementation was initiated, the majority of the 148 children who received care were female and younger than 5 years of age (Table 1).

The overall percentage of children categorized as having a normal nutritional status increased for both the acute (60% versus 77%, $P = 0.001$) and chronic (67% versus 82%, $P = 0.003$) categories (Figure 1). Of the children with acute undernutrition, or wasting, at baseline, 81% were in the mild category, 19% in the moderate category, and 0% in the severe category. No children were categorized as severe acute under-

TABLE 1
Demographic data for 2005 (baseline) and 2006 (post-intervention)

	Baseline (November 2005)	Post-intervention (November 2006)
No. of children	175	148
Female (%)	91 (52%)	71 (48%)
Age (years)		
0–5	103 (59%)	84 (57%)
6–11	56 (32%)	47 (32%)
> 12	16 (9%)	17 (11%)
Mean age (years)	5.3	5.6

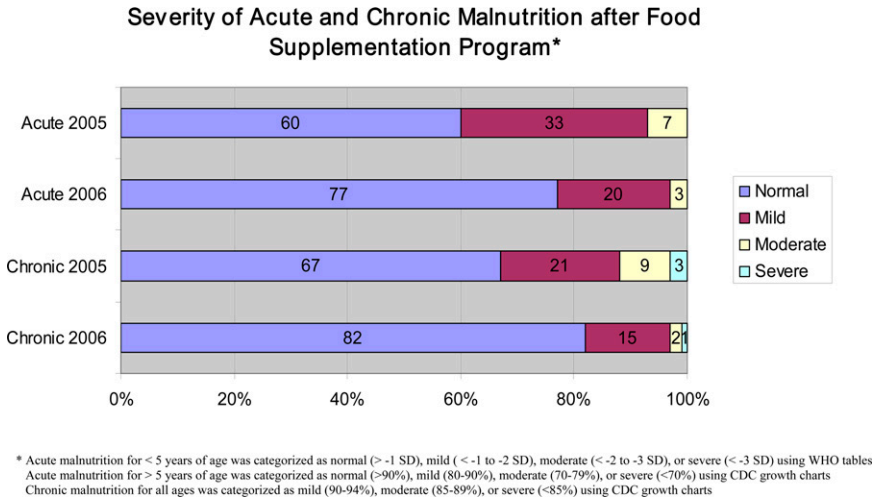

FIGURE 1. Severity of acute and chronic malnutrition after the food-supplementation program. This figure appears in color at www.ajtmh.org.

nutrition. There was a decrease in the percentage of children categorized as mild (33% versus 20%, $P = 0.004$) and moderate acute undernutrition (7% versus 3%, $P = 0.004$) between baseline and post-intervention. There was an overall reduction in undernutrition among all bateyes ($P = 0.001$); this reduction was statistically significant in two of five individual bateyes (Figure 2). In Figure 3, improvements in the rates of undernutrition were noted for both males (38% versus 23%, $P = 0.04$) and females (42% versus 23%, $P = 0.01$). Analyses of change by age distribution show significant improvements in the 0- to 5-year group (36% versus 15%, $P = 0.002$) and the 6- to 11-year group (48% versus 28%, $P = 0.03$), but a non-significant increase in the 12-year and older group (38% versus 47%, $P = 0.579$).

Of the children with chronic undernutrition, or stunting, at baseline, 63% were in the mild category, 28% were in the moderate category, and 9% were in the severe category. There was a decrease in the percentage of children in the mild (21% versus 15%, $P = 0.006$), moderate (9% versus 2%, $P = 0.006$), and severe (3% versus 1%, $P = 0.006$) categories between baseline and post-intervention. Although there was less chronic malnutrition in all bateyes post-intervention compared with baseline, this improvement was statistically significant in only one of the five bateyes (Figure 4). In Figure 5, improvements in rates of chronic undernutrition were noted in males (40% versus 20%, $P = 0.007$) and females (25% versus 16%, $P = 0.129$). When divided by age groups, trends of improvement existed in all three age categories, but only the 6- to 11-years group had statistical significance ($P = 0.027$).

DISCUSSION

This study shows that integrating food-assistance programs with routine health care in rural communities in the Dominican Republic can significantly improve the nutritional status of children. With collaborations between local physicians and the CHOP Global Health Program, the nutrition program was strengthened by focusing on high-risk children, modifying the food-package content to provide higher calories and nutritional value, and linking the program with mobile clinics that provide routine care to these rural communities. Working together, this program has increased access to nutritional assessment and management of these impoverished populations. The integration of a food-supplementation program with routine health care through mobile clinics may be an intervention that can be replicated in other rural areas.

In a seminal series of articles published in *The Lancet* regarding maternal and child undernutrition, various nutrition-related interventions were reviewed and analyzed to determine standards for comparing effectiveness in terms of childhood survival.[5] The authors subdivided interventions into major thematic groups. (1) interventions to improve general nutrient intake (both quality and quantity): breastfeeding

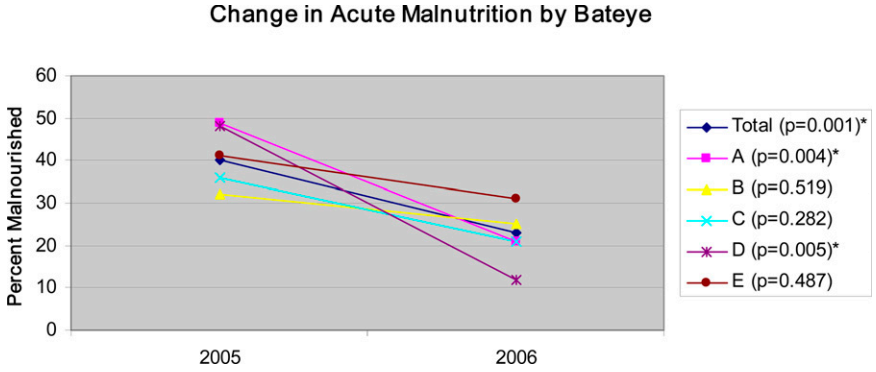

FIGURE 2. Change in acute malnutrition by bateye. This figure appears in color at www.ajtmh.org.

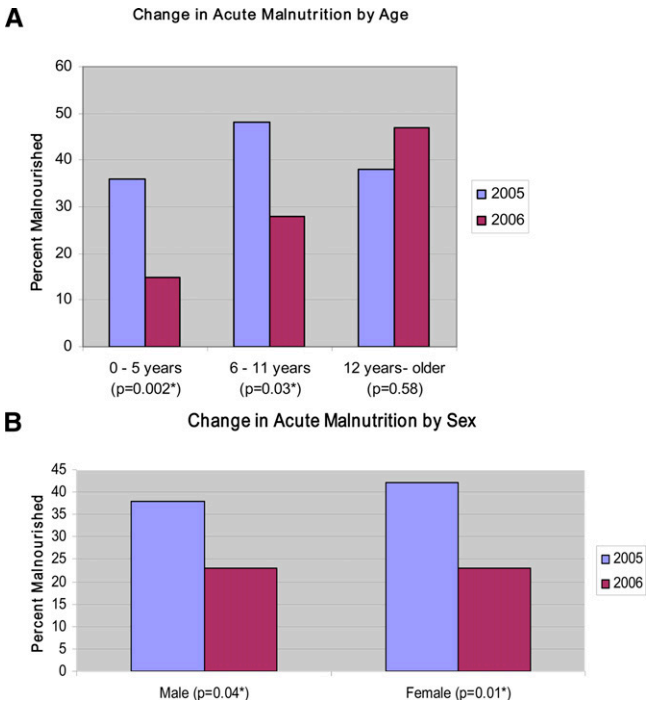

FIGURE 3. (**A**) Change in acute malnutrition by age. (**B**) Change in acute malnutrition by sex. This figure appears in color at www.ajtmh.org.

promotion and complementary-feeding support nutritional education with or without food supplements; (2) micronutrient interventions: food fortification with micronutrients, supplements with iron, dispersible micronutrient preparation, vitamin A supplements, zinc supplements, iodine supplementation, and delayed cord clamping; (3) disease-prevention strategies: interventions that reduce malaria burden during pregnancy and reduce neglected tropical-disease burden and diarrheal diseases in childhood as well as improve hygiene and sanitation measures; (4) general nutrition-support strategies: conditional cash transfers and dietary diversification strategies. In respect to nutrition education with or without food supplementation, the authors conducted a meta-analysis in which countries were divided into food-insecure and food-secure nations. In populations with sufficient food, education about complementary feeding increased height for age *Z* score by 0.25 (95% confidence interval = 0.01–0.49). However, provision of food supplements (with or without education) in populations with insufficient food increased the height for age *Z* score by 0.41 (0.05–0.76). The authors of *The Lancet* series consider that complementary-feeding counseling and support strategies in food-insecure populations could substantially reduce the burden of stunting and related disease.[5] The CHOP Global Health program integrates health care through mobile clinics and food supplementation and provides a point of entry for rural and remote communities. This multidisciplinary approach in collaboration with local physicians may be a successful intervention in other remote areas.

The rural bateyes in the Dominican Republic are areas where food security is a major concern, and so, food-supplementation programs can address the burden of undernutrition. Significant reductions in the prevalence of acute and chronic undernutrition were seen in this study over a 1-year period. The magnitude of improvement among the children with acute undernutrition was greater than the improvement among the children with chronic undernutrition; the improvement in acute but not chronic undernutrition was likely related to the short time period over which this intervention was assessed. Although there was a trend of improvement in each of the undernutrition subcategories (mild, moderate, and severe), these rates were not statistically significant, perhaps because of small sample size. However, when the undernutrition variables were grouped into dichotomous categories (normal and undernourished), significant improvements were shown. There are also some interesting differences in rates of acute and chronic malnutrition in relation to sex and age. There was a non-statistical increase in acute malnutrition rates in the older age group; this effect may be related to the small sample size in the older subgroup (9% and 11% of total sample in 2005 and 2006, respectively) compared with the younger age groups. Increased rate of chronic malnutrition in the older age group and males is difficult to explain without further qualitative exploration and may represent selection bias rather than a true effect in the general population as well as a short time interval (1 year) to assess changes in chronic malnutrition.

Although the results of this program are favorable, there are limitations to this study. Evaluation of the program was done on a community level rather than on the individual level, and so, we were not able to account for migration between different bateyes. Because this is a take-home food program rather than a direct feeding program, the possibility of leakage exists. In one study, only 40–60% of foods in take-home programs went to the targeted child.[6] The design of this study does not allow certainty that the improvement in anthropometric measurements of children after program implementation is solely a result of the food-supplementation program.

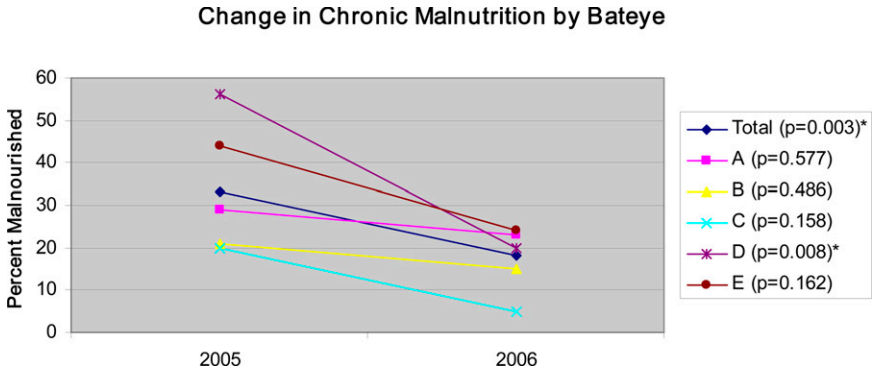

FIGURE 4. Change in chronic malnutrition by bateye. This figure appears in color at www.ajtmh.org.

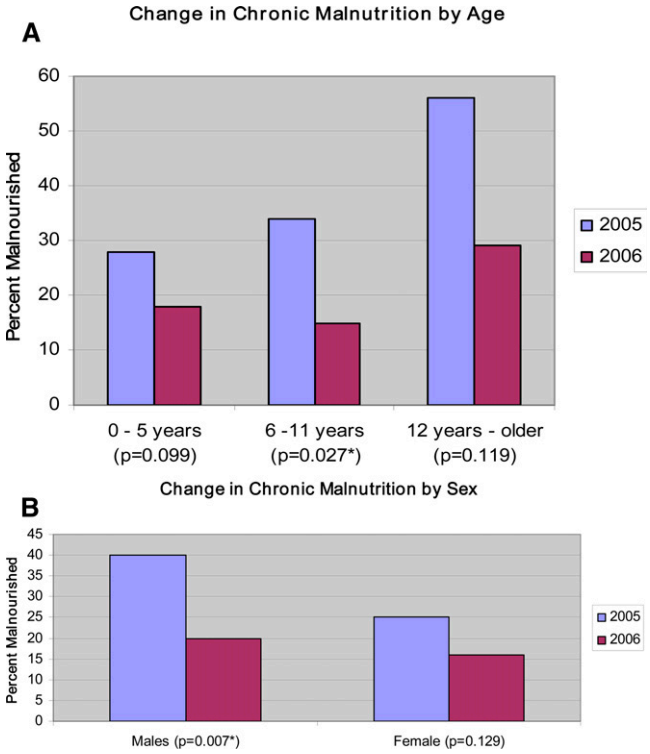

FIGURE 5. (**A**) Change in chronic malnutrition by age. (**B**) Change in chronic malnutrition by sex. This figure appears in color at www.ajtmh.org.

Although limitations to the study exist, strengths of this intervention may benefit other food-supplementation programs. First, linking the nutrition program with routine health-care visits may increase accessibility to the program for families as was previously reported by Beaton and Ghassemi.[6] This integration of food distribution with routine health care through mobile clinics is a model that may be considered in other countries with rural regions. Second, community health workers were trained to identify high-risk children, collect proper anthropometrics, and counsel families on nutrition by the CHOP Global Health teams at least two times a year. These community health workers are trained by the CHOP Global Health teams on how to educate and support families to promote health and nutrition. These types of health-promotion activities have been shown to improve the nutritional status of children independent of food supplementation and are considered a key component in sustaining change.[10] Collaborating with the local physicians and community health workers are important for building capacity and strengthening education for families in the bateyes to improve long-term health and nutrition. Lastly, the CHOP Global Health team worked in conjunction with the Dominican health workers and physicians to enhance the program and provide educational support to the Dominican team. Although funding for the food-supplementation program may be limited, educational outreach of the community health workers is an ongoing component of the program coordinated by Dominican physicians.

Although this program included treatment of undernourished children, preventative measures are crucial as well. A nutrition program in Haiti showed that a preventative model for delivering food assistance was more effective at reducing childhood undernutrition than the traditional treatment model of targeting underweight children.[11] Preventative programs include education as well as development and support for community health workers. The CHOP Global Health program integrated these components to enhance the preventative strategy in conjunction with food supplementation. Program sustainability is also a concern, and whereas financial constraints and economic hardships may take time to address, families can be educated on breastfeeding practices and appropriate complementary foods as well as social marketing forces in the region. The CHOP Global Health program engaged in these preventative strategies by providing educational support to the community health workers to encourage healthy feeding practices; this aspect of the program is meant to provide avenues for long-standing change and improvement in the overall nutrition status of the community.

Achieving the MDG target of halving the proportion of undernourished children between 1990 and 2015 will require multifactorial and multilevel response and intervention. Unicef proposed a four-tier system. Micro-level interventions will empower families and communities to improve their health and feeding practices for pregnant women and children. Meso-level interventions will strength community efforts and improve sanitation and hygiene. Macro-level interventions will integrate child health and nutrition into national policies and budgets. Finally, global-level interventions will ensure sustainable improvements.[12] This food-supplementation program linked with routine health care is a type of micro-level intervention that should be explored further as a means for improving the nutritional health of children in impoverished communities.

Received August 21, 2009. Accepted for publication April 9, 2010.

Authors' addresses: Kavita Parikh, Pediatric Hospitalist Division, Children's National Medical Center, Washington, DC, E-mail: kparikh@cnmc.org. Gabriela Marein-Efron, Pediatrics Residency Program, Children's Hospital of Philadelphia, Philadelphia, PA, E-mail: mareinefrong@email.chop.edu. Shirley Huang, Division of GI, Hepatology, and Nutrition, Children's Hospital of Philadelphia, Philadelphia, PA, E-mail: huangs@email.chop.edu. Geraldine O'Hare and Rodney Finalle, Division of Global Health, Children's Hospital of Philadelphia, Philadelphia, PA, E-mails: ohare@email.chop.edu and finalle@email.chop.edu. Samir Shah, Department of Global Health and the Divisions of Infectious Disease and General Pediatrics, Children's Hospital of Philadelphia, Philadelphia, PA and Departments of Pediatrics and Biostatistics and Epidemiology, University of Pennsylvania School of Medicine, Philadelphia, PA, E-mail: shahs@email.chop.edu.

REFERENCES

1. Black RE, Morris SS, Bryce J, 2003. Where and why are 10 million children dying every year? *Lancet 361:* 2226–2234.
2. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, Mathers C, Rivera J, 2008. Maternal and Child Undernutrition Study Group Maternal and Child Undernutrition 1: global and regional exposures and health consequences. *Lancet 371:* 243–260.
3. United Nations, 2009. *End Poverty Millennium Development Goals 2015*. Available at: http://www.un.org/millenniumgoals/bkgd.shtml. Accessed April 6, 2009.
4. Food and Agriculture Organization of the United Nations, 2000. *The State of Food Insecurity in the World*. Rome, Italy: Food and Agriculture Organization of the United Nations.
5. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev HP, Shekar M, 2008. Maternal and Child Undernutrition 3: what works? Interventions for maternal and child undernutrition and survival. *Lancet 371:* 417–440.

6. Beaton GH, Ghassemi H, 1982. Supplementary feeding program for young children in developing countries. *Am J Clin Nutr 35:* 884–916.
7. Harris AD, Bradham DD, Baumgarten M, Zuckerman IH, Fink JC, Perencevich EN, 2004. The use and interpretation of quasi-experimental studies in infectious disease. *Clinical Infectious Diseases 38:* 1586–1591.
8. World Health Organization, 2006. *WHO Child Growth Standards: Length/Height for Age, Weight for Age, Weight for Length, Weight for Height and Body Mass Index for Age: Methods and Development*. Geneva: World Health Organization.
9. Waterlow JC, Buzina R, Keller W, Lane JM, Nichaman MZ, Tanner JM, 1977. The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. *Bull World Health Organ 55:* 489–498.
10. Roy SK, Fuchs GJ, Mahmud Z, Ara G, Islam S, Shafique S, Akter S, Chakraborty B, 2005. Intensive nutrition education with or without supplementary feeding improves the nutritional status of moderately-malnourished children in Bangladesh. *J Health Popul Nutr 23:* 320–330.
11. Ruel MT, Menon P, Habicht JP, Loechl C, Bergeron G, Pelto G, Arimond M, Maluccio J, Michaud L, Hankebo B, 2008. Age-based preventative targeting of food assistance and behaviour change and communication for reduction of childhood undernutrition in Haiti: a cluster randomized trial. *Lancet 371:* 588–595.
12. Unicef, 2006. *Unite for Children Publications. Unite for Children: Progress for Children. A Report Card on Nutrition*. Available at: http://www.unicef.org/publications/index_33685.html. Accessed April 6, 2009.